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March 27, 2013

Mr. Bruce Morrison
Project Manager
U.S. Environmental Protection Agency, Region 7
11201 Renner Boulevard
Lenexa, KS 66219

RE: Baseline Groundwater Monitoring Plan
2012 Annual Report - Revised
Former Solutia – John F. Queeny Plant
St. Louis, Missouri
EPA ID No. MOD 004 954 111

Dear Mr. Morrison:

This letter accompanies the delivery of the revised *Annual Baseline Groundwater Monitoring Report* for the Former Solutia John F. Queeny Plant to U.S Environmental Protection Agency (EPA). This revised report is in response to comments received in the letter from EPA dated January 18, 2013, which incorporated comments from the Missouri Department of Natural Resources. Note that in conserving resources, the hard copy provided consists only of components of Volume I, as no changes were made to components in Volume II. Please replace the respective components with those provided here. An electronic version of the entire revised report is also provided.

Please let me know if you would like additional copies. I can be reached by phone at 314-480-4694, or via email at larryr@environmentalops.com.

Respectfully submitted,

Lawrence C. Rosen

Lawrence C. Rosen, R.G. / Project Manager
Environmental Operations, Inc.

Attachment: 2012 Annual Baseline Groundwater Report – Former Solutia Queeny Plant

Copies: *Mr. Matt Robinson/EOI*
Mr. Michael House/Solutia
Mr. Rich Nussbaum/MDNR
Ms. Christine Kump-Mitchell/MDNR

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Environmental Operations, Inc.
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Annual Baseline Groundwater Monitoring Report

Former Solutia Queeny Plant
St. Louis, Missouri

Volume I –
Text, Tables, Graphs, and Figures

Prepared for:

SWH Investments II

Prepared by:

Environmental Operations, Inc.
1530 South 2nd Street
St. Louis, Missouri 63104

November 30, 2012

Rev 1 March 27, 2013

Annual Baseline Groundwater Monitoring Report

Former Solutia Queeny Plant
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Volume II –
Appendices A - F

Prepared for:

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CERTIFICATION

Annual Baseline Groundwater Monitoring Report

State of Missouri Registered Professional Certification Page

I certify that I am a qualified geologist and groundwater scientist who has received a post graduate degree in the natural sciences, and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and remediation of soil and groundwater. I further certify that this report was prepared by me or by a subordinate working under my direction.

Lawrence C. Rosen, R.G.
Registration No.: RG0012
Date: 3-27-13

STATE OF MISSOURI
LAWRENCE C ROSEN
3-27-13
RG 0012
REGISTERED GEOLOGIST

Eric J. Page, R.G.
Environmental Operations, Inc.
Date: 3/22/13

STATE OF MISSOURI
ERIC J. PAGE
3/22/13
RG0974
REGISTERED GEOLOGIST

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APPENDICES

List of Acronyms and Abbreviations

Acronym/Abbreviation	Definition
APA	Acetanilides Production Area
AST	Above-ground storage tank
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
cm	centimeters
CFR	Code of Federal Regulations
CMS	Corrective Measure Study
COC	Constituents of Concern
DNAPL	Dense Non-Aqueous Phase Liquids
EOI	Environmental Operations, Inc.

FBCSA	Former Bulk Chemical Storage Area
GPS	Global Positioning System
IMWP	Interim Measures Work Plan
kg	kilogram
LNAPL	Light non-aqueous phase liquids
MDNR	Missouri Department of Natural Resources
MNA	Monitored Natural Attenuation
mg	Milligrams
NAPL	Non Aqueous Phase Liquid
PCB	Polychlorinated biphenyls
PPE	Personal protective equipment
PRG	Project Remediation Goal
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
Site	Former Solutia Queeny Plant
SOP	Standard Operating Procedures
SWMU	Solid Waste Management Unit
TSCA	Toxic Substances Control Act
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank

1 INTRODUCTION

1.1 Purpose

The Baseline Groundwater Monitor Plan, dated October 6, 2010, approved by United States Environmental Protection Agency – Region VII (EPA), was developed to evaluate site-wide groundwater for the former FF Building Area and the former acetanilides production area (APA), and monitor groundwater discharging to the Mississippi River from the former bulk chemical storage area (FBCSA). The program also monitors continued plume stability and monitored natural attenuation (MNA) parameters. This program consists of the following elements: monitoring well installation and development; water level and non-aqueous phase liquid (NAPL) gauging, well inspections and maintenance and groundwater sampling; data management, evaluation and reporting.

The annual report is a comprehensive report which includes evaluation, analysis, and recommendations with the summary of the validated laboratory analytical data and copies of the laboratory data. Except for the groundwater remediation activity in the form of injections, activities associated with the Interim Measures Work Plan are not part of this report.

1.2 Location

The Former Solutia J.F. Queeny Plant (Queeny Plant or Site) located between Lesperance and Barton Streets and First and Second Streets in St Louis, Missouri. A single address often provided for the Queeny Plant is 200 Russell Street, St Louis, Missouri. Figure 1 is a general Site Location Map showing the Queeny Plant located in the western portion of the Cahokia, Illinois, U.S. Geological Survey (USGS) topographic quadrangle. SWH Investments II legally purchased the Queeny Plant and assumed the environmental obligations for the property effective June 13, 2008. Environmental Operations, Inc. (EOI), in affiliation with SWH Investments II, is assuming the responsibilities for the environmental obligations for the Queeny Plant in order to prepare the property for redevelopment for light industrial and commercial use.

2 BACKGROUND

2.1 Site Description

The Queeny Plant occupies approximately 36 contiguous acres and is located in eastern St. Louis City approximately between First and Second Streets and Lesperance and Barton Streets; a separate parcel of approximately two acres (i.e., the FBSCA) lies south of the contiguous 36 acres at the northeast intersection of First and Victor Streets. The Queeny Plant is located in the western portion of the Cahokia, Illinois, U.S. Geological Survey (USGS) topographic quadrangle (Figure 1). The plant is located on the west bank of the Mississippi River at River Mile 178.

The Queeny Plant is located in an area that is zoned and developed for industrial and commercial uses and is expected to remain so for the foreseeable future. The site is proximate to a major transportation corridor provided by the Mississippi River, several interstate highways, and a large railroad center. Figure 2 is an aerial photograph that shows the Queeny Plant in relation to the surrounding area. Areas surrounding the facility are used for industrial and commercial operations. Current access to the site is restricted.

2.2 Site History

The Monsanto Chemical Works began site operations on six acres at its current location in 1901 with the chemical manufacturing of Saccharin. In 1933 Monsanto Chemical Works changed its name to Monsanto Chemical Company. The company underwent another re-naming in 1964 and became the Monsanto Company. Solutia Inc. was formed from a spin-off of the chemicals business of the Monsanto Company on September 1, 1997.

Since its inception, the Queeny plant has manufactured over 200 products using over 800 raw materials. The major products have included but are not limited to the following: process chemicals such as maleic anhydride, fumaric acid, toluene sulfonic acid, and paranitrophenetole; plasticizers such as phthlate esters and toluene sulfonamides; synthetic functional fluids such as Pydrauls™, Skydrols™, and coolanols; food and fine chemicals such as salicylic acid, aspirin, methyl salicylate, benzoic acid, and ethavan; and agricultural chemicals such as Lasso ™ (i.e., acetanilides or alachlor). The three areas which this work covers are briefly described below.

FF Building Area. The area associated with the FF Building that constitutes the SWMU includes the footprint of the former building (an area of approximately 150 feet by 75 feet) and the surrounding area including a former underground storage tank (UST). The ground covering in this area is asphalt, and crushed and compacted stone. This area is currently not used and no buildings are located in the area.

Former Acetanilides Production Area. The APA produced acetanilides or alachlor also referred to as Lasso™, and it is located in the south-central portion of the Queeny Plant. The estimated size of this manufacturing block is 300 feet by 450 feet. This production area began operations in 1966, as a multi-product facility. The Lasso™ operations ceased in 1991. The ground covering in this area consists of buildings, asphalt, concrete foundations of former aboveground storage tanks, and railroad ballast near the railroad spur.

Former Bulk Chemical Storage Area. The FBCSA approximates a parallelogram shaped parcel of land approximately 285 feet by 300 feet, or approximately 1.94 acres. It was purchased by Monsanto in 1968 from Clark Oil Company and included two 500,000 gallon aboveground storage tanks (ASTs) and two 300,000 gallon ASTs that were used by Clark for fuel storage. After the 1968 purchase, raw materials used at the Queeny Plant were unloaded from a barge terminal, located on the west bank of the Mississippi River, and pumped into these tanks for storage. Materials stored at the terminal by Monsanto and others included: petroleum products, alkyl benzenes, blends of alkyl benzenes (Purex A-220 and Canadian A-221), Santicizer 154 plasticizer (p-t-butylphenyl diphenyl phospate), monochlorobenzene, ortho-nitrochlorobenzene, sodium hydroxide, and potassium hydroxide. The use of this area was discontinued in 1987 and the tanks were removed. This area has at times been leased to other companies as open space storage.

The ground covering in this area is asphalt, crushed and compacted stone, and sparse volunteer vegetation. The SWMU is located outside of the Queeny Plant main property and site security fence, but is enclosed by a locked security fence.

3 SITE ACTIVITY

The BGMP identified the need to install wells to complete the network in addition to collection of groundwater samples. This section briefly describes well installation activities and groundwater sample collection.

3.1 Monitor Well Installation

Monitoring well installation began on property accessible to EOI. This included installation of monitoring wells MW-32A, MW-33A, MW-33B, MW-39A, and MW-39B. Well locations for MW-36A, MW-36B, MW-38A, and MW-38B were on property owned by Mr. Ted Ahrens. Access to his property was not obtained and the wells installed until after the second quarterly event, so groundwater analytical results for those wells begin with the third quarter. MW-5 on the east side of the APA could not be found after several attempts to locate the well. A replacement well designated MW-5R was installed in March 2012. Well installation boring logs and well installation/construction details are presented in Appendix A. Wells designations with the "A" suffix, were screened in the fill/silty clay unit. Those with the "B" suffix were installed in the underlying sand unit.

Wells were installed in accordance with state of Missouri guidelines by a permitted Missouri well driller. Monitoring wells were constructed of two-inch diameter Schedule 40 polyvinyl chloride (PVC) casing, with a minimum ten foot section of 0.010-in. well screen. The surface completion of the monitoring wells included placement of a concrete pad, installation of locking caps and stickup or flush mount well covers, and placement of bumper posts, as necessary. Table 1 is a summary of the groundwater monitoring well installation information, including total depths, screened intervals, and hydrogeologic unit.

3.2 Monitor Well Development

The monitoring wells were developed to remove the fines from the well and sand pack. This was performed using a conventional groundwater pump or equivalent methods suitable for well development. Each monitoring well was developed until a minimum of five well volumes were removed and pH, specific conductance, and temperature readings stabilize within 10% over a minimum of two successive readings. In addition, the turbidity of the development water was observed to ensure that fines have been removed.

3.3 Groundwater Sampling

Prior to each sampling round, groundwater level and NAPL measurements were obtained from the available existing network of monitoring wells and piezometers at the site. These data were used to develop groundwater elevation contour maps during the two sampling events for each hydrostratigraphic zone. Figures 3, 5, 7, and 9 are for the clay and silt unit for the first through fourth quarters. Figures 4, 6, 8, and 10 are for the bedrock and sand units for the first through fourth quarters.

Groundwater samples were collected using low-flow methodologies including a flow-through cell. The groundwater sampling proceeded from the least impacted wells to the most impacted in each of the areas. Equipment used for sampling that could contact groundwater was properly decontaminated before each use. Field instruments were calibrated prior to use in accordance with the manufacturer's specifications.

The monitoring wells were purged using a conventional groundwater pump, suitable for low flow applications (i.e., bladder pump [or equivalent]). Field documentation noted drawdown and pumping rate. Each monitoring well was purged until pH, specific conductance, and temperature stabilized over a minimum of three successive flow-through cell volumes. In addition, turbidity was measured but not used as sampling criteria. The field parameters were measured and recorded on monitoring well sampling sheets during purging.

After the relevant parameters stabilized, the flow-through cell was bypassed for sampling. Personnel conducting the groundwater sampling wore clean disposable protective gloves.

To verify field and laboratory procedures, quality assurance/quality control (QA/QC) samples consisting of duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, matrix spike/matrix duplicate ((MS/MD) MNA only), and trip blanks were collected and submitted to the laboratory. QA/QC samples were collected at a frequency of 10% for duplicates and blanks and 5% for MS/MSDs. One trip blank (prepared by the lab) accompanied each cooler shipment containing samples for VOC analysis.

A chain-of-custody documentation was completed by the field sampler and provided for each sample cooler. Sampling containers were packed in such a way as to help prevent breakage and cross-contamination. Samples were shipped in coolers, each containing a chain-of-custody form(s) and ice packs to maintain inside temperature at approximately 4°C ± 2°C. Sample coolers were sealed between the lid and sides of the cooler with a custody seal prior to shipment. Samples were either picked up by Pace or hand-delivered to their facility at 4120 Seven Hills Drive in Florissant, Missouri.

3.3.1 First Quarter Event

The first quarter of sampling was initiated on August 29, 2011. Representatives from the MDNR accompanied EOI personnel during the collection of water levels as part of a well audit. MDNR representatives were also present during sample collection, which began on August 30, 2011. Samples were collected on August 30, 31, September 1, 2, 6, 22, and 23, 2011. MDNR personnel were present on September 6, 2011 to collect split samples. EOI did not have access to existing wells on Mr. Ahrens property to the north.

3.3.2 Second Quarter Event

The second quarter sampling commenced on December 19, 2011. EOI met with Mr. Ahrens to access existing wells in his property that previously had not been accessible or sampled under this plan. Groundwater samples were collected on December 19-22, 28, and 29, 2011.

3.3.3 Third Quarter Event

The third quarter sampling commenced on March 27, 2012. EOI met with Mr. Ahrens to access existing wells and the recently installed wells under this plan. Groundwater samples were collected on March 28-29, April 2-3, and 9-12, 2012.

3.3.4 Fourth Quarter Event

The fourth quarter sampling commenced on June 25, 2012. As before, EOI met with Mr. Ahrens to access existing wells on his property that get sampled under this plan. Groundwater samples were collected on June 26-28, July 2, 5, 9, and 11-12, 2012.

4 GEOLOGY AND GROUNDWATER FLOW

4.1 General Site Geology

The site area is considered to be part of the Mississippi River flood plain. A significant amount of development has occurred over the past 200 years and the associated filling activities have raised the ground surface elevation and extended it eastward. The stratigraphy beneath the site consists of four main units (from top down), fill, silty clay, sand, and limestone bedrock. A bedrock high beneath the central portion of the facility affected the configuration of some of these units, and also influences groundwater conditions. The fill and silty clay unit are present across the site. The sand unit is present beneath the silty clay in the northern and southern portions of the site, away from the bedrock high. The sand, where present, extends downward to bedrock. Bedrock occurs at depths varying from 10 feet to approximately 80 feet beneath the site. Limestone bedrock underlies the site to the depths explored.

The general grain-size of alluvial-colluvial deposits above the bedrock becomes coarser with depth, from clay to sand. Four stratigraphic units have been identified beneath the facility. The upper fill unit is typically 3 to 23 feet thick; and mainly consists of silty clay but also contains sand, gravel, cinders and other debris. The former Quarry Area is an exception to this in that the fill is in excess of 100 feet thick. Below the fill, across most of the site, is a relatively lower permeability fine-grained alluvial silt and clay unit with some areas of clayey silt and interbedded sand seams. The silty clay is absent in some areas across the site, predominately in the former Quarry Area where the overburden was removed during the quarrying of the underlying limestone. The silty clay is generally gray to olive gray and moist and extends to approximately 27 feet bgs. The sand seams are usually water saturated and generally appear to be physically and hydraulically isolated.

In the northern and southern portions of the site a sand unit underlies the silty clay and extends to bedrock. The sand unit consists mainly of fine to medium sand with some silt and coarse sand. This sand unit is generally water saturated through the entire thickness of the unit. The sand is absent in the central portion of the site where a bedrock high exists. On the bedrock high, the fill and silty clay directly overlies the bedrock (i.e., the central portion of the APA and the VV Building Area).

Underlying the sand (and fill and silty clay on the bedrock high) is the bedrock unit, which is represented by the St. Louis Limestone Formation. The limestone bedrock is described as finely to coarsely crystalline, fractured, and weathered. This unit contains chert, and interbedded layers of shale and clay. In some areas, the bedrock surface is weathered, ranging in thickness from 2 to 10 feet based on borings OBW-1 through OBW-3. In the area of the bedrock high, the shallowest depth to bedrock is less than 10 feet. Away from the bedrock high, the depth to bedrock is as much as 91 feet bgs. In the southeastern portion of the site, a former limestone quarry extended to over 100 feet bgs. The quarry has since been filled. The bedrock surface generally slopes to the east toward the Mississippi River.

A more detailed description of the geology of the four SWMUs is summarized as follows:

VV Building Area

- Fill and silty clay, 0 to 8 feet bgs
- Silt and/or sand, 8 to 9 feet bgs
- Bedrock varies from approximately 7 to 10 feet bgs

Former FF Building Area

- Fill and silty clay, 0 to 20 feet bgs
- Variable silts and sands, 20 to 31 feet bgs
- Bedrock varies from approximately 31 to 60 feet bgs

Former Acetanilides Production Area

- Fill and silty clay, 0 to 7 feet bgs
- Silty sand, 7 to 8 feet bgs
- Bedrock varies from approximately 8 to 12 feet bgs.

FBCSA

- Fill and silty clay, 0 to 22 feet bgs
- Silty sand, 22 to 36 feet bgs
- Sand, 36 to 79 feet bgs
- Bedrock approximately 79 feet bgs

4.2 Hydrogeology

On a large scale, groundwater flows characteristically from west to east in the site area toward the major groundwater discharge feature of the area, the Mississippi River. However, within the Former Queeny Plant, local groundwater flow is influenced by the bedrock high noted in the central portion of the site. Shallow groundwater in this area generally flows radially off the bedrock high and then east toward the river once it is off the bedrock high. The sand unit represents the major groundwater migration pathway due to its hydraulic properties (i.e., relatively thick and permeable). Groundwater in the bedrock unit appeared to generally flow east toward the Mississippi River. The primary pathways of flow within the bedrock are through secondary porosity features including fractures, joints, bedding planes, or solution cavities.

Groundwater at the site is encountered within three major water-bearing zones, as introduced previously. The uppermost zone is within the fill and silty clay that covers the entire site. The majority of the water in this zone is contained within the various sand lenses encountered in the silty clay; however, there are some zones of granular material in the fill that yield water. When separate, the units can only be contoured on a very local basis. This is due to characteristics such as the variable fill thickness and the silty clay unit being absent in certain areas and not containing water in certain areas. Therefore, they are contoured together and the groundwater potentiometric surface map for the fill and silty clay hydrostratigraphic unit is shown in Figures 3, 5, 7, and 9; the sand and bedrock units shown in Figures 4, 6, 8, and 10. Table 1 provides the groundwater gauging measurements from the last four quarters.

Thin lenses of permeable material in the fill and silty clay unit are likely isolated and do not exhibit significant communication with the river, but primarily serve as connective media with the underlying sand.

The entire thickness of the sand unit is generally confined with depths to water ranging from approximately 17 feet to 35 feet bgs. The overlying silty clay appears to confine the upper horizon of the sand unit, whereas the bedrock appears to confine the lower horizon of the sand unit.

Groundwater flow in the bedrock is expected to be through fracture, joint, bedding plane, and solution cavity systems. The flow direction in the bedrock is influenced by the orientation of corresponding fractures, joints, bedding planes, etc. in addition to recharge from or discharge to the river and the driving head of groundwater. Three monitoring wells are screened in bedrock; OBW-1, OBW-2, and OBW-3. Given the hydraulic connection of the sand and bedrock units, they are contoured together and depicted in the groundwater potentiometric surface maps as a single hydrostratigraphic unit.

During the past 12 months, the region has experience drought conditions, and the Mississippi River stage has been relatively low and for an extended period. Average responses in the shallow fill/silty clay wells were negligible to about a one foot drop in groundwater elevation. Average responses in the sand wells in the northern portion varied from minimal to three foot drop in groundwater elevation; some sand well groundwater elevations in the southern portion dropped over 10 feet. Bedrock groundwater elevations dropped about one foot in the interior site locations; about six feet for the one farthest east to ward the river. Discussion of groundwater flow is presented in the following section.

4.3 Groundwater Flow

4.3.1 First Quarter – September 2011

The contoured potentiometric surface for the fill and silty clay unit was limited by not having access to the Ahrens property to the north for data collection. The obtained values depict a general flow to the southeast across the site (Figure 3). The underlying sand and bedrock unit mirror this flow, with a slightly more southerly component closer to the Mississippi River (Figure 4).

4.3.2 Second Quarter – December 2011

The contoured potentiometric surface for the fill and silty clay unit, having more data points, indicated more influence from the bedrock high. The obtained values depict a general flow to the northeast from the FF Area, and aspects of both an easterly flow and southeasterly flow from the APA Area (Figure 5). The underlying sand and bedrock unit had primarily an easterly flow from the FF and APA Areas, with a slight turn southerly as it passed the FBCSA and on toward the Mississippi River (Figure 6).

4.3.3 Third Quarter – March 2012

The contoured potentiometric surface for the fill and silty clay unit, having more data points, again indicated more influence from the bedrock high. The obtained values depict a general flow to the north from the FF Area, and aspects of both an easterly flow and south-southeasterly flow from the APA Area (Figure 7). The underlying sand and bedrock unit had primarily an easterly flow from the FF and APA Areas, with a turn to the south as it passed the FBCSA and on toward the Mississippi River (Figure 8).

4.3.4 Fourth Quarter – June 2012

The contoured potentiometric surface for the fill and silty clay unit continued to show the influence from the bedrock high. A general north flow from the FF Area was evident, and aspects of both an easterly flow and southeasterly flow from the APA Area (Figure 9). The lower groundwater elevation in the southern portion appears to reflect the low river stage at the time. The underlying sand and bedrock unit was similar to the prior quarter, and had primarily an easterly flow from the FF Building and APA Areas, turning southerly toward the FBCSA and on to the Mississippi River (Figure 10).

4.3.5 Additional Hydrogeologic Parameters

During previous investigations, slug tests were performed on various wells within the fill and silty clay. Slug tests which effectively measure the most permeable material in the screened zone produced hydraulic conductivity values of 5.1×10^{-5} to 1.1×10^{-2} centimeters per second (cm/sec) for the fill and silty clay. These higher values are influenced by the more permeable granular material in the fill or sandy lenses in the silty clay.

The potential communication between the groundwater within the fill and silty clay and the river was evaluated during correlation monitoring conducted by O'Brien & Gere (1999). During this investigation, the communication between wells screened in the fill and silty clay at the FBCSA and Mississippi River was evaluated over a one year period. The O'Brien and Gere investigation (1999) determined that a negative or only minor communication existed between the groundwater in the fill and silty clay and the river. An investigation by URS (2007) determined that there is delayed communication between the fill and silty clay. It is speculated that the thin lenses of permeable material in the fill and silty clay unit are isolated and do not exhibit significant communication with the river, but primarily serve as connective media with the underlying sand.

The entire thickness of the sand unit is generally confined with depths to water ranging from approximately 17 feet to 35 feet bgs. The overlying silty clay appears to confine the upper horizon of the sand unit, whereas the bedrock appears to confine the lower horizon of the sand unit. The groundwater flow direction in the sand is generally east, toward the river, as depicted in the Figures 3 - 10. Slug tests and pump tests performed during previous investigations produced average hydraulic conductivity values of 5.6×10^{-2} cm/sec for the sand located north and south of the bedrock high.

A comparison of the potentiometric surface in wells screened at different depths in the sand unit was conducted during the RFI Data Gap Investigation (URS, 2002). The comparison showed very little vertical component, which indicates that groundwater flow is generally horizontal. This indicated that the sand unit is the primary pathway for offsite migration.

Groundwater flow in the bedrock is expected to be through fracture, joint, bedding plane, and solution cavity systems. The flow direction in the bedrock is largely influenced by the orientation of corresponding fractures, joints, bedding planes, etc. in addition to recharge from or discharge to the river and the driving head of groundwater. Seven monitoring wells were screened in bedrock, including wells MW-2R, MW-8R, MW-13R, MW-21R, OBW-1, OBW-2, and OBW-3. Observations of groundwater elevation data in regards to the bedrock wells is summarized as follows.

- Wells MW-2R, MW-8R, OBW-1 and OBW-2 are bedrock wells above which the sand unit exists. Wells MW-2R and MW-8R are located along the eastern perimeter of the site and have associated wells MW-2B and MW-8B screened in the sand. Comparison of water levels in these wells showed an upward hydraulic gradient. Wells OBW-1 and OBW-2 do not have associated wells screened solely in the sand.

- Wells MW-13R and MW-21R, and OBW-3 are located in the bedrock high where the sand unit is absent. The bedrock in this area is overlain with the fill and silty clay unit. Well MW-13R has an associated shallow well MW-13. Water levels in these wells suggested a downward gradient. MW-21R is located in the bedrock high and there are no shallow wells in the vicinity of this well. Well OBW-3 is located near well MW-9, which is screened in the fill and silty clay unit. Water levels reported for these two wells also suggest a downward hydraulic gradient.

These results suggested that flow near the bedrock high area is vertically downward from the fill and silty clay to bedrock and, as the distance away from bedrock high increases, there is a reversal in the vertical direction of flow and flow is from bedrock to the sand unit. Water level measurements in bedrock wells suggest that the flow is generally from west to east (i.e., toward the river).

5 GROUNDWATER REMEDIATION ACTIVITY

5.1 Introduction

The selected alternative for groundwater remediation involves the injection of reagents to oxidize source materials in the subsurface. The selected reagents are proprietary products available through Regeneis. These included RegenOx™, a chemical oxidant from Regenesis that is capable of treating a broad range of chemicals in soil and groundwater. It is designed to aggressively attack high concentration source areas. RegenOx ™ has two components: an oxidant and an activator. They may be mixed in varying proportions into a solution with water. The RegenOx™ may also be combined with another Regenesis product ORC Advanced™ , which slowly releases oxygen to the groundwater system to stimulate aerobic bioremediation for a more extended period. Oxidizing reagents were injected into the subsurface targeting the capillary fringe zone and the saturated zone in the intended geological unit.

The presence of chlorinated compounds in the FF Area was addressed with injection of 3D Microemulsion with BioDechlor Innoculum (BDI®). 3-D Microemulsion incorporates a hydrogen releasing component, specifically designed to time release a combination of highly efficient electron donors. 3-D Microemulsion produces hydrogen and to distribute hydrogen-generating compounds to the subsurface through a series of hydration and fermentation reactions. This process provides for an immediate as well as time-release supply of hydrogen to fuel the demands of the anaerobic reductive dechlorination process. Bioaugmentation for the degradation of chlorinated compounds in soil and groundwater was enhanced through the addition of cultured anaerobic microorganisms for the biodegradation of certain target compounds. The reductive dechlorination of PCE and TCE leads to daughter products DCE and vinyl chloride. BDI® incorporates specific strains of anaerobic bacteria for the biodegradation of DCE and vinyl chloride.

Injection was made using direct-push technology provided by a subcontractor, CABENO. CABENO provided the requisite geoprobe rigs, mix tanks, pumps, and hoses to inject the designated solution volumes at each location. EOI provided oversight to implement the injection plan and document the work. The field work began on November 29, 2011 and was completed December 16, 2011.

5.2 Injection Activity

The presence of impacts observed in the groundwater for the fill/silty clay unit and the sand/bedrock unit indicated that the original approach of fixed injection points would be too limiting if subsequent injection events were needed. Under the assumption that an injected area had already achieved local source reduction, a subsequent event would be offset and provide the intended additional source reduction sought. The following plan was implemented for the injection event.

5.2.1 FBCSA Treatment

The treatment in the FBCSA was divided into three different injection areas associated with existing wells: MW-25 A&B; MW-5, VM-1 and VM-2; and MW-24 A&B. The approach for each area is described as follows. For MW-25 A&B, the injection interval was typically from 20-45 feet bgs. These included injection points IP1-FBCSA-1 through 8, and 16-19. Injection compounds consisted of 1188 lbs. of RegenOx Part A, and 1104 lbs. of ORC Advanced mixed in accordance with the manufacturer's instructions. Table 2 shows the details for each injection completed, included depths, injection pressure, injection volume, product type, and pounds used. Figure 13 depicts the location of the injection points.

For MW-5, VW-1 and VW-2, the injection interval was typically from 5-15 feet bgs. These included injection points IP1-FBCSA-9 through 15, and 20-40. Injection compounds consisted of 1288 lbs. of RegenOx Part A and 840 lbs. of ORC Advanced.

For MW-24 A&B, the injection interval was typically from 20-45 feet bgs. These included injection points IP1-FBCSA-41 through 50. Injection compounds consisted of 1320 lbs. of RegenOx Part A and 1000 lbs. of ORC Advanced.

5.2.2 APA Treatment

The treatment in the APA was divided into two different areas: An area encompassing GM-1 and 2 and extending to the north; and around MW-4. The approach for each is described as follows. For the GM-1 area, the injection interval was from the top of bedrock and upward five feet. The depth to bedrock varied from nine to 18 feet bgs. These included injection points IP1-APA-51 through 83. Injection compounds consisted of RegenOx with Part A and B, and ORC Advanced mixed in accordance with the manufacturer's instructions. Table 2 shows the details for each injection completed, included depths, injection pressure, injection volume, product type, and pounds used. Figure 14 depicts the location of the injection points.

For MW-4, the injection interval was typically from 5-15 feet bgs. These included injection points IP1-FBCSA-84 through 91. Injection compounds consisted of RegenOx with Part A and B, and ORC Advanced.

5.2.3 FF Area Treatment

The treatment in the FF Area was divided into three different areas: the vicinity of LPZ-2 and 5; the vicinity of OBW-2; and an area surrounding REC-4. The approach for each is described as follows. For the LPZ-2 and 5 area, the injection interval was typically from 7 to 17 feet bgs. These included injection points IP1-FF-102 through 116. Injection compounds consisted of 825 lbs. of RegenOx Part A, 450 lbs. of RegenOx B, and 600 lbs. of ORC Advanced mixed in accordance with the manufacturer's instructions. Table 2 shows the details for each injection completed, included depths, injection pressure, injection volume, product type, and pounds used. Figure 15 depicts the location of the injection points.

For the area at depth around OBW-2, the injection interval was 1-2 feet above bedrock in the sand unit. Depth to bedrock varied from 58 to 69 feet bgs. These included injection points IP1-FF-92 through 101. Injection compounds consisted of 660 gallons of 3D Microemulsion and 16 liters of BDI mixed in accordance with the manufacturer's instructions.

For the area surrounding REC-4, the injection interval was typically from 15 to 25 feet bgs. These included injection points IP1-FF-117 through 126. Injection compounds consisted of 540 gallons of 3D Microemulsion and 10 liters of BDI mixed in accordance with the manufacturer's instructions.

6 ANALYTICAL DATA

The analytical data are summarized in the report tables. The tables are separated by area of the Site, with the first page for a well location having the VOC data, and the second page the lab and field values for the MNA parameters. For any given location, if two columns are shown for a given date, the second column represents a duplicate analysis. Graphical representations of the data are provided where sufficient data exist to produce a meaningful graph which permits visual observation of trends, if present. Therefore not every well has a graph, and the graphed constituents will vary. Formal laboratory reports for the four quarters are presented in Appendices B through E, respectively. Field sampling forms are presented in Appendix F. Discussion of the results is presented in Section 6.

7 DATA EVALUATION

This section presents the groundwater results of the BGMP. Up to 47 monitoring wells were sampled and analyzed each quarter, depending on access or presence of groundwater in a well. The primary objective was to obtain a current understanding of site-wide groundwater conditions and to evaluate the relative effectiveness of remediation activities under the IMWP.

Groundwater analytical results were screened against published human health-based criteria referenced in the work plan. This served as a means to focus attention on those analytes that are the primary contributors to site risk. Groundwater data were compared against MCLs, or USEPA Region 3/6 RSL values for tap water if MCLs were not available. Comparisons were made against historic concentrations and existing concentration prior to remedial activities geared at reducing contaminant concentrations, with an alternate goal of 75% reduction as compared to concentrations present in the 2004-2005 time frame. If data were lacking from that period, comparisons were made to either older data or data generated at the start of the baseline groundwater monitoring.

The results are presented first by SWMU/AOC, and secondly by hydrostratigraphic unit. Within each of these units, results are presented based on the apparent source areas and resultant impact areas. The laboratory analytical results for the groundwater samples collected during this investigation are summarized in tables section by well, and where sufficient data exist, in graphs to more readily visualize changes. Breaks in the graphs represent no data for a given event. This may be the result of laboratory detection limits, no groundwater, or that a well was not accessible.

7.1 FF Area

Former leaking underground storage tank(s) (LUST) associated with the former FF Building Area contributed to the observed groundwater detections. Groundwater impacts extend from the source area northeast or east toward the northeastern property boundary, i.e., downgradient. The monitored wells in the fill/silty clay unit include MW-2B, MW-3, MW-28A, MW-30A, MW-36A, MW-38A, MW-39A, LPZ-2, LPZ-4, and LPZ-5. The monitored wells in the sand/bedrock unit include MW-2A, MW-28B, MW-30B, MW-36B, MW-38B, MW-39B, REC-1, REC-4, OBW-1, OBW-2, and OBW-3.

The key analytes identified within this source area were the PCE degradation suite, chlorobenzene, and toluene. Each constituent within the PCE degradation suite was detected in the former FF Building Area. In general, analytical results indicated the highest concentrations of PCE were detected in samples collected from wells within the source area. No DNAPL was observed in these wells during the quarterly sampling. TCE, DCE, and vinyl chloride were detected in wells within the source area. They were also detected in samples from wells outside the source area, with vinyl chloride present in more downgradient wells than TCE and DCE. The presence of vinyl chloride at the downgradient edge of the impacted area supports the conclusion that biodegradation is occurring via reductive dechlorination. As expected when

TCE and DCE in a groundwater plume biodegrade, the lighter (molecular weight) and more mobile constituent, vinyl chloride, is found further from the source.

The FF area had RegenOx and ORC Advanced injected to address primarily the toluene, secondarily the chlorobenzene and vinyl chloride via in-situ chemical oxidation. 3D MicroEmulsion (3DME) with Biodechlor was injected to remediate PCE and its biodegradation suite. Note that the injection can physically cause movement in source materials, and can also initially mobilize, via desorbtion, source material from the soil and into the groundwater. Consequently, observed increases in COC concentrations can occur after injection, followed by decreases as biodegradation processes take over.

7.1.1 Data Trends

Bedrock wells OBW-1 and 2 have concentrations suggesting the presence of DNAPL, though none was observed. Both show increases in the cis-1,2 DCE, with decreases in parent compounds, indicating the impact of the 3DME in promoting reductive dechlorination. In the case of OBW-2, the plume is fluctuating, given non-detects in each of the first two quarters. Notably, the concentration in June 2012 shows the parent compounds PCE and TCE, and chlorobenzene reduced by greater than 75% relative to July 2000. At OBW-3, concentrations of the COCs have dropped by orders of magnitude since September 2011, and are presently below MCLs. Evidence of anaerobic conditions suitable to promote biodegradation was detected in the monitored natural attenuation parameters. Figures 11 and 12 depict the historic concentrations at respective well locations in the fill/silty clay and sand/bedrock units, respectively.

Sand unit wells in the source area, REC-1 and 4, appear to also reflect favorable effects from the injection. REC-1 shows general declines in PCE and TCE, with a rise in cis-1,2 DCE, indicating anaerobic reductive dechlorination was occurring. This was corroborated by the decrease in DO, pH, and sulfate, with an increase in methane, ethane, and dissolved iron and manganese.

Fill/silty clay unit wells in the source area include MW-3, LPZ-2, LPZ-4, and LPZ-5. MW-3 has had detectable concentrations of PCE, TCE, and cis-1,2 DCE decrease by one or two orders of magnitude, and have been reduced by over 75%, placing them close to or below the MCLs. Toluene concentrations in LPZ-2, LPZ-4, and LPZ-5 remain above MCLs. The monitored natural attenuation parameters show mixed indications regarding the degree of chemical oxidation and aerobic bioremediation. LPZ-2 is the downgradient well of the three, and its toluene concentration in the fourth quarter was at an historic low and represents a 75% reduction. The chlorinated COCs are showing a rise in the cis-1,2 DCE concentrations, with either non-detect or decreasing parent compounds. Again, LPZ-2 in the fourth sampling event had significant decreases, with the cis-1,2 DCE below MCLs. The data indicate plume stabilization and contraction toward the source.

Background/upgradient wells are represented by MW-2A, MW-2B, MW-39A, and MW-39B. MW-2A and MW-2B had below MCL detections of chlorobenzene, chloroform, and cis-1,2 DCE in the first event, and non-detect for the COCs in the three subsequent events. MW-39A and MW-39B had below MCL detections for chlorobenzene and/or cis-1,2 DCE in the first event, and non-detect for COCs in the three subsequent events. Each of these four wells has met remedial criteria goals.

Downgradient wells are represented by MW-28A, MW-28B, MW-30A, and MW-30B. There have been fewer sampling events for these wells and meaningful trends are not established. COCs were below MCLs in MW-28A and MW-30A. Chlorobenzene was detected above the MCLs in both MW-28B and MW-30B.

Monitoring wells MW-36A, MW-36B, MW-38A, and MW-38B were installed in March 2012 after access to the proposed locations was provided by the property owner. These were designated as downgradient wells given their location relative to the FF Area. The data from the two sampling events subsequent to their installation indicate a different scenario. MW-38A, the shallow well, screened from 8 to 18 feet below ground surface in the fill/silty clay well had the highest concentrations detected. PCE and TCE were detected in April 2012 at 8950 and 1960 micrograms/liter (μg/l), with cis-1,2 DCE at 216,000 μg/l and VC at 18,100. MW-38B, screened in the deeper sand unit, had only 4.4 μg/l PCE, 2.8 μg/l cis-1,2 DCE, and 14.2 μg/l VC. This contrast is not consistent with a source in the FF Area for these constituents. The monitored natural attenuation parameters indicate that anaerobic bioremediation is occurring.

MW-36A and MW-36B data supports being downgradient from a separate PCE/TCE source, with the shallow well, MW-36A, having no detections for the parent products or the degradation suite. MW-36B, screened in the sand unit, with 77.7 μg/l cis-1,2 DCE, and 609 μg/l VC detected with no PCE or TCE in July 2012, represents the expected downgradient degradation of the parent products. It was the only location with detectable 1,2 DCA. The data from MW-36A and B and MW-38A and B indicate a different source than the FF Area for the PCE/TCE suite.

7.2 APA Area

This area is located above and on the southeastern side of the bedrock high. The associated groundwater impact follows the radial groundwater flow off of the bedrock high. The monitored wells in the fill/silty clay unit include MW-4, MW-5R, MW-9, MW-11A, MW-13, MW-15, MW-19, MW-23, GM-1, and GM-2. GM-1 and GM-2 are considered source area wells, the rest are downgradient wells. The key analytes identified in this source area were chlorobenzene and alachlor. Some PVC well casings in the source area were tinted red, which, according to Solutia, is a dye that is mixed in the Lasso™ formulation. The concentrations of chlorobenzene and alachlor were located mainly within the source area; however, some detections extend downgradient to the north, east, and southwest.

The APA had RegenOx and ORC Advanced injected to address the chlorobenzene and alachlor to promote both chemical oxidation and aerobic biodegredation. Note that the injection can physically cause movement in source materials, and can also initially mobilize source material from the soil and into the groundwater. Consequently, observed increases in COC concentrations can occur after injection, followed by decreases as degradation takes over.

7.2.1 Data Trends

The source area wells, GM-1 and GM-2, have shown significant reduction in detected concentrations. In GM-1, alachlor has gone from a high of 191,000 μg/l in December 2011 to 88,700 μg/l in June 2012. Similarly, chlorobenzene has gone from a high of 180,000 μg/l in June 2000 to 59,100 μg/l in April 2012, with a rebound to 106,000 μg/l in June 2012. In GM-2, alachlor has decreased from a high of 120,000 μg/l in September 2011 to 62,900 μg/l in June 2012. Similarly, chlorobenzene has decreased from a high of 94,000 μg/l in August 2004 to 32,000 μg/l in April 2012, with a rebound to 69,400 μg/l in June 2012. The natural attenuation parameters indicated a significant change immediately after the injection, with tailing values over time as the injection product was consumed.

MW-19, located north of the APA, showed initial significant reduction in chlorobenzene, dropping from 68,700 μg/l in September 2011 down to 9220 μg/l in December 2011, followed by rebound to 39,000 μg/l in July 2012. Residual alachlor was present at 8.43 μg/l in July 2012. No other COCs were detected. MW-5R, located northeast from the APA, had low concentrations of chlorobenzene, cis-1,2 DCE, and VC, with only VC slightly above the MCL at 4.9 μg/l. Given the observed groundwater flow patterns and the detected concentrations, MW-19 may represent an isolated source impacting groundwater, rather than the downgradient migration from the APA.

MW-9, MW-13, and MW-23 are downgradient wells located east of the APA. MW-9 had no detectable COCs. MW-13 has seen a significant drop of chlorobenzene to below MCLs at 13.7 μg/l. Alachlor was detected at 13.4 μg/l. At MW-23, only alachlor and chlorobenzene were detected, and at concentrations below their respective MCLs.

MW-11A is located south of the APA. For the last two quarters the only COC detected was alachlor. The concentration in June 2012 was slightly above its MCL at 3.68 μg/l.

MW-4 and MW-15 are located southwest of the APA. At MW-4 the concentrations of chlorobenzene had been reduced by over 75% from 1740 μg/l in September 2011 to 225 μg/l in June 2012. The only other detection was alachlor which was slightly above the MCL at 12 μg/l. In June 2012, the only detected compound at MW-15 was chlorobenzene at 3.5 μg/l, which is below its MCL.

In general, the alachlor and chlorobenzene plume appears stable and remains primarily constrained to the source area, concentrated around wells GM-1 and GM-2.

7.3 FBCSA

The source area is bounded on the downgradient side by Wharf Street to the east, and Victor Street to the south. Source area wells include MW-24A, MW-24B, MW-25A, MW-25B, VW-1, FBCSA-MW-5, VW-2, AND VW-2B. Background wells include HW-1 and HW-2. Downgradient wells include MW-31B, MW-32A, MW-32B, MW-33A, MW-33B, and MW-34B. The key analytes detected in this area were chlorobenzene, and benzene/petroleum hydrocarbons. Intermittent, low concentrations of the PCE degradation suite constituents have been detected at this location. Consequently, injection treatment was limited to ORC Advanced and RegenOx to meet remedial objectives.

The FBCSA had RegenOx and ORC Advanced injected to address the chlorobenzene and petroleum hydrocarbons to promote both chemical oxidation and aerobic biodegredation. Note that the injection can physically cause movement in source materials, and can also initially mobilize source material from the soil and into the groundwater. Consequently, observed increases in COC concentrations can occur after injection, followed by decreases as degradation takes over.

7.3.1 Data Trends

HW-1 is designated as an upgradient well screened in the sand unit. There were no detected COCs in the August 2011 event. The well has been dry in the subsequent three quarters. HW-2 is in the fill/silty clay. There were no detected COCs in the August 2011 or December 2011 events. The well is in a private parking area which was covered by additional gravel and HW-2 could not be found and was not accessible during the next two quarters.

MW-24A had greater than 75% reduction in the benzene, chlorobenzene, and methylene chloride relative to concentrations detected prior to injection and those detected in the July 2012. Toluene and xylene were at or below their MCLs. In MW-24B in the sand unit, the injection appeared to cause a significant increase in the concentrations of benzene, chlorobenzene, and toluene. This was followed by chemical oxidation and aerobic bioremediation, such that concentrations dropped significantly. The detected concentrations as of the July 2012 event were less than 75% of the 2005 concentrations.

In MW-25A, since injection, COCs were either not detected or below their respective MCLs. In MW-25B, similar results were obtained; however, benzene and VC were present, with detected concentrations just above their MCLs at 7.9 μg/l and 4.5 μg/l, respectively. Other source area wells, VW-1, VW-2, and VW-2B had mixed results. VW-1 and VW-2 in the fill/silty clay had chlorobenzene above the MCL; however, chlorobenzene concentrations were significantly reduced in VW-1. VW-2B in the sand unit had COCs below MCLs except for VC, which had decreased by over 70% relative to 2005 concentrations.

Wells MW-32A and MW-33A are downgradient wells in the fill/silty clay unit. MW-32A had no COCs detected above their MCLs; however, the well was dry during the April and July 2012 sampling events. MW-33A have not had any of the COCs detected above MCLs.

Wells MW-32B and MW-33B are downgradient wells in the sand unit. MW-32B historically had benzene in part per million concentrations. Benzene is no longer detected. Chlorobenzene was present at 641μg/l in July 2012, which is comparable to historic concentrations; however, concentrations had been below MCLs, even non-detect for most COCs in August and December 2011. MW-33B followed a similar pattern of detections for chlorobenzene. The reason for the significant decrease, even no detection, followed by a return to historic concentrations was not evident. A review of historic river stage data did not indicate an influence that would explain this pattern. The working hypothesis is that the injection event is the key factor in the observed changes.

MW-34B is the southern-most downgradient sand unit well. Historically, there have been intermittent detections of various COCs, each time below respective MCLs. This pattern held for the most recent quarterly sampling, with detections of only benzene at 1.1 µg/l, and chlorobenzene at 9.3 µg/l.

Overall, the injection treatment was effective in producing significant decreases in contaminant concentrations in the source area.

8 CONCLUSIONS AND RECOMMENDATIONS

The data obtained from the 47 wells comprising the baseline groundwater monitoring network have been sampled on a quarterly basis for one year in the majority of wells. Since monitoring was started, remediation tasks described in the Interim Measures Work Plan (IMWP) were initiated. This included the injection of RegenOx™ (Parts A and B), ORC Advanced™, and 3D MicroEmulsion™ with Bio Dechlor™ into the subsurface to promote the chemical oxidation and aerobic or anaerobic biodegradation of the COCs in the Former FF Building Area, the Former Acetanilides Production Area, and the Former Bulk Chemical Storage Area.

The results indicated that the initial application of these injection products has been reasonably effective, locally achieving either 75% reduction or MCL levels in some locations, and in other locations promoting plume stabilization. Consequently, evaluation of additional treatment was being pursued to broaden the achievement of the remedial goals in those areas that indicated the need, consistent with the IMWP, and to consider the potential for rebound. The data also reveal that there appear to be two isolated locations which are considered to be source areas rather than representations of contaminant migration. The two locations are associated with MW-19 and MW-38A, respectively. The design for additional treatment will consider those areas.

On the basis of the collected data, we are proposing to modify the sampling schedule for the groundwater network as shown in the following table:

Monitoring Area	Monitoring Location ID and Criteria	Frequency
Former FF Building Area	**Fill and Silty Clay Unit**	
	MW-2B - Background and side-gradient	Annually
	MW-39A - Background	Annually
	MW-3 - Source Area Well	Annually
	LPZ-2 - Source Area Well	Semi-annually
	LPZ-4 - Source Area Well	Quarterly
	LPZ-5 - Source Area Well	Quarterly
	MW-28A - Downgradient Well	Semi-annually
	MW-30A - Downgradient Well	Quarterly
	MW-36A - Downgradient Well	Quarterly
	MW-38A - Downgradient Well	Quarterly

Monitoring Area	Monitoring Location ID and Criteria	Frequency
Former FF Building Area	**Sand Unit**	
	MW-39B - Background and up-gradient	Annually
	MW-2A - Background and side-gradient	Annually
	MW-28B - Downgradient Well	Quarterly
	MW-30B - Downgradient Well	Quarterly
	MW-36B - Downgradient Well	Quarterly
	MW-38B - Downgradient Well	Quarterly
	REC-1 - Source Area Well	Quarterly
	REC-4 - Source Area Well	Semi-annually
	Bedrock Unit	
	OBW-1 - Source Area Well	Quarterly
	OBW-2 - Source Area Well	Quarterly
	OBW-3 - Downgradient Well	Quarterly
Former Bulk Chemical Storage Area	**Fill and Silty Clay Unit**	
	HW-2 - Background Well	Annually if accessible
	VW-1 - Source Area Well	Quarterly
	VW-2 - Source Area Well	Quarterly
	MW-24A - Source Area Well	Quarterly
	MW-25A - Source Area Well	Semi-annually
	FBCSA-MW-5 - Source Area Well	Quarterly
	MW-32A-Downgradient Well	Semi-annually
	MW-33A-Downgradient Well	Semi-annually
	Sand Unit	
	HW-1 - Background Well	Annually if accessible
	VW-2B - Source Area Well	Semi-annually
	MW-24B - Source Area Well	Quarterly
	MW-25B - Source Area Well	Semi-annually
	MW-31B - Downgradient Well	Semi-annually
	MW-32B - Downgradient Well	Semi-annually
	MW-33B - Downgradient Well	Semi-annually

Monitoring Area	Monitoring Location ID and Criteria	Frequency
	MW-34B - Downgradient Well	Semi-annually
Former Acetanilides Production Area	**Fill and Silty Clay Unit**	
	MW-15 - Background and downgradient	Semi-annually
	GM-1 - Source Area Well	Quarterly
	GM-2 - Source Area Well	Quarterly
	MW-4 - Downgradient Well	Quarterly
	MW-5 - Downgradient Well	Semi-annually
	MW-9 - Downgradient Well	Semi-annually
	MW-11A - Downgradient Well	Annually
	MW-13 - Downgradient Well	Semi-annually
	MW-19 - Downgradient Well	Quarterly
	MW-23 - Downgradient Well	Semi-annually

Note that a fifth quarter of sampling has been completed. This fifth round would constitute the annual event for wells at that recommended frequency, and the first round for the semi-annual wells. No change is recommended at this time for the analytical suite for the respective locations. After the second year, we will re-evaluate the sampling frequency and make recommendations to both the schedule and the wells that will be monitored.

9 REPORT LIMITATIONS

This report has been prepared in accordance with normally accepted environmental engineering practices for groundwater monitoring and reporting. Conclusions presented in this report are EOI's interpretation and comprise a professional opinion based on this data. No other warranty, express or implied, is made regarding the information presented in this report. In the event that conclusions and recommendations, based on the data presented in this report, are made by others, such conclusions and recommendations are their responsibility.

EOI has exercised reasonable skill, care, and diligence in preparation of this report in accordance with generally accepted standards of good professional practice in effect at the time this report was prepared.

Conditions inferred to exist between sampling points might differ significantly from actual conditions. Changes in subsurface conditions can be influenced by many factors. These factors include but are not limited to: management of surrounding areas, off-site contaminant sources, seasonal rainfall fluctuations, changes in contaminant source area and composition, groundwater occurrence, and biodegradation. Over time, actual conditions revealed through sampling can vary due to natural occurrences and/or man-made interference on or near the site.

10 REFERENCES

O'Brien & Gere Engineers, Inc. 1999. *RCRA Facility Investigation Data Gap Work Plan*. Prepared for Solutia Inc.

URS Corporation, July 2002. RCRA Facility Investigation Data Gap Investigation Report, J.F. Queeny Plant, St. Louis, Missouri.

URS Corporation, May 2007. RCRA Corrective Measure Study – J.F. Queeny Plant.

TABLE 1

SUMMARY OF SITE-WIDE WELL COMPLETION INFORMATION

TABLE 2

INJECTION DATA

Table 2
Injection Data

Injection Point	Date	Bottom Injection Depth [ft bgs]	Top Injection Depth [ft bgs]	RegenOx Part A [lbs]	RegenOx Part B [lbs]	ORC Advanced [lbs]	3D Micro Emulsion	BDI (L)	Water Volume [gal]	Injection Pressure [psi]	Total Injected Volume [gal]	Flow Rate [gpm]
IP1-FBCSA-1	11/29/2011	45	20	99	x	92	x	x	225	30	255	3
IP1-FBCSA-2	11/29/2011	45	20	99	x	92	x	x	225	55	255	3
IP1-FBCSA-3	11/29/2011	45	20	99	x	92	x	x	225	110	255	3
IP1-FBCSA-4	11/30/2011	45	20	99	x	92	x	x	225	30	255	3
IP1-FBCSA-5	11/30/2011	45	20	99	x	92	x	x	225	50	255	3
IP1-FBCSA-6	11/30/2011	45	20	99	x	92	x	x	225	40	255	4
IP1-FBCSA-7	11/30/2011	45	20	99	x	92	x	x	225	30	255	3
IP1-FBCSA-8	11/30/2011	45	20	99	x	92	x	x	225	50	255	4
IP1-FBCSA-9	11/30/2011	15	5	46	x	30	x	x	105	55	120	3
IP1-FBCSA-10	11/30/2011	15	5	46	x	30	x	x	105	30	120	2
IP1-FBCSA-11	12/1/2011	15	5	46	x	30	x	x	105	40	120	3
IP1-FBCSA-12	12/1/2011	15	5	46	x	30	x	x	105	35	120	3
IP1-FBCSA-13	12/1/2011	15	5	46	x	30	x	x	105	35	120	3
IP1-FBCSA-14	12/1/2011	15	5	46	x	30	x	x	105	30	120	4
IP1-FBCSA-15	12/1/2011	15	5	46	x	30	x	x	105	30	120	3
IP1-FBCSA-16	12/1/2011	45	20	99	x	92	x	x	225	30	255	3
IP1-FBCSA-17	12/1/2011	45	20	99	x	92	x	x	225	30	255	4
IP1-FBCSA-18	12/1/2011	45	20	99	x	92	x	x	225	30	255	3
IP1-FBCSA-19	12/1/2011	45	20	99	x	92	x	x	225	30	255	4
IP1-FBCSA-20	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-21	12/1/2011	15	5	46	x	30	x	x	105	30	125	2
IP1-FBCSA-22	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-23	12/1/2011	15	5	46	x	30	x	x	105	40	125	4
IP1-FBCSA-24	12/1/2011	15	5	46	x	30	x	x	105	30	125	4
IP1-FBCSA-25	12/1/2011	15	5	46	x	30	x	x	105	30	125	4
IP1-FBCSA-26	12/1/2011	15	5	46	x	30	x	x	105	30	125	5

Table 2
Injection Data

Injection Point	Date	Bottom Injection Depth [ft bgs]	Top Injection Depth [ft bgs]	RegenOx Part A [lbs]	RegenOx Part B [lbs]	ORC Advanced [lbs]	3D Micro Emulsion	BDI (L)	Water Volume [gal]	Injection Pressure [psi]	Total Injected Volume [gal]	Flow Rate [gpm]
IP1-FBCSA-27	12/1/2011	20	10	46	x	30	x	x	105	30	125	4
IP1-FBCSA-28	12/1/2011	20	10	46	x	30	x	x	105	30	125	4
IP1-FBCSA-29	12/1/2011	20	10	46	x	30	x	x	105	30	125	4
IP1-FBCSA-30	12/1/2011	15	5	46	x	30	x	x	105	30	125	4
IP1-FBCSA-31	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-32	12/1/2011	15	5	46	x	30	x	x	105	30	125	4
IP1-FBCSA-33	12/1/2011	15	5	46	x	30	x	x	105	30	125	6
IP1-FBCSA-34	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-35	12/1/2011	15	5	46	x	30	x	x	105	30	125	2
IP1-FBCSA-36	12/1/2011	15	5	46	x	30	x	x	105	110	125	3
IP1-FBCSA-37	12/1/2011	15	5	46	x	30	x	x	105	30	125	2
IP1-FBCSA-38	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-39	12/1/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-40	12/2/2011	15	5	46	x	30	x	x	105	30	125	3
IP1-FBCSA-41	12/2/2011	45	20	132	x	100	x	x	300	30	350	3
IP1-FBCSA-42	12/2/2011	45	20	132	x	100	x	x	300	30	350	3
IP1-FBCSA-43	12/2/2011	45	20	132	x	100	x	x	300	60	350	3
IP1-FBCSA-44	12/2/2011	45	20	132	x	100	x	x	300	55	350	3
IP1-FBCSA-45	12/2/2011	45	20	132	x	100	x	x	300	50	350	4
IP1-FBCSA-46	12/2/2011	45	20	132	x	100	x	x	300	55	350	3
IP1-FBCSA-47	12/2/2011	45	20	132	x	100	x	x	300	40	350	4
IP1-FBCSA-48	12/5/2011	44	19	132	x	100	x	x	300	60	350	5
IP1-FBCSA-49	12/5/2011	45	20	132	x	100	x	x	300	50	350	4
IP1-FBCSA-50	12/5/2011	45	20	132	x	100	x	x	300	45	350	5
IP1-APA-51	12/7/2011	12	7	28	30	20	x	x	75	30	85	4
IP1-APA-52	12/7/2011	13	8	28	30	20	x	x	75	30	85	3

Table 2
Injection Data

Injection Point	Date	Bottom Injection Depth [ft bgs]	Top Injection Depth [ft bgs]	RegenOx Part A [lbs]	RegenOx Part B [lbs]	ORC Advanced [lbs]	3D Micro Emulsion	BDI (L)	Water Volume [gal]	Injection Pressure [psi]	Total Injected Volume [gal]	Flow Rate [gpm]
IP1-APA-53	12/7/2011	14	9	28	30	20	x	x	75	30	85	3
IP1-APA-54	12/15/2011	15	10	28	30	20	x	x	75	30	85	2
IP1-APA-55	12/15/2011	15	10	28	30	20	x	x	75	30	85	2
IP1-APA-56	12/15/2011	12.5	7.5	28	30	20	x	x	75	30	85	2
IP1-APA-57	12/15/2011	14	9	28	30	20	x	x	75	30	85	3
IP1-APA-58	12/15/2011	10	5	28	30	20	x	x	75	30	85	2
IP1-APA-59	12/15/2011	9	4	28	30	20	x	x	75	30	85	3
IP1-APA-60	12/15/2011	11	6	x	x	53	x	x	15	30	90	2
IP1-APA-61	12/15/2011	13	8	x	x	53	x	x	15	30	90	2
IP1-APA-62	12/15/2011	15	10	x	x	53	x	x	15	30	90	2
IP1-APA-63	12/15/2011	14	9	28	30	20	x	x	75	30	85	3
IP1-APA-64	12/15/2011	15	10	28	30	20	x	x	75	30	85	3
IP1-APA-65	12/15/2011	16	11	28	30	20	x	x	75	30	85	3
IP1-APA-66	12/15/2011	17	12	28	30	20	x	x	75	30	85	3
IP1-APA-67	12/15/2011	16	11	28	30	20	x	x	75	30	85	3
IP1-APA-68	12/15/2011	14	9	28	30	20	x	x	75	30	85	4
IP1-APA-69	12/15/2011	18	13	28	30	20	x	x	75	30	85	4
IP1-APA-70	12/16/2011	15	10	28	30	20	x	x	75	30	85	3
IP1-APA-71	12/16/2011	16	11	x	x	53	x	x	15	30	90	3
IP1-APA-72	12/16/2011	17	12	x	x	53	x	x	15	30	90	3
IP1-APA-73	12/16/2011	18	13	28	30	20	x	x	75	30	85	3
IP1-APA-74	12/16/2011	14	9	28	30	20	x	x	75	30	85	3
IP1-APA-75	12/16/2011	12	7	28	30	20	x	x	75	30	85	3
IP1-APA-76	12/16/2011	11	6	28	30	20	x	x	75	30	85	3
IP1-APA-77	12/16/2011	12	7	28	30	20	x	x	75	45	85	3
IP1-APA-78	12/16/2011	14	9	28	30	20	x	x	75	30	85	3

Table 2
Injection Data

Injection Point	Date	Bottom Injection Depth [ft bgs]	Top Injection Depth [ft bgs]	RegenOx Part A [lbs]	RegenOx Part B [lbs]	ORC Advanced [lbs]	3D Micro Emulsion	BDI (L)	Water Volume [gal]	Injection Pressure [psi]	Total Injected Volume [gal]	Flow Rate [gpm]
IP1-APA-79	12/16/2011	13	8	28	30	20	x	x	75	30	85	4
IP1-APA-80	12/16/2011	14	9	28	30	20	x	x	75	30	85	4
IP1-APA-81	12/16/2011	15	10	x	x	53	x	x	15	30	90	2
IP1-APA-82	12/16/2011	15	10	28	30	20	x	x	75	30	85	2
IP1-APA-83	12/16/2011	16	11	28	30	20	x	x	75	30	85	3
IP1-APA-84	12/15/2011	8	7	x	x	40	x	x	30	30	40	3
IP1-APA-85	12/15/2011	7	6	x	x	40	x	x	30	30	40	3
IP1-APA-86	12/15/2011	8	7	x	x	40	x	x	30	30	40	3
IP1-APA-87	12/15/2011	8	7	x	x	40	x	x	30	25	40	3
IP1-APA-88	12/15/2011	9	8	x	x	40	x	x	30	30	40	3
IP1-APA-89	12/15/2011	9	8	x	x	40	x	x	30	30	40	3
IP1-APA-90	12/15/2011	9.5	8.5	x	x	40	x	x	30	30	40	3
IP1-APA-91	12/15/2011	8	7	x	x	40	x	x	30	30	40	3
IP1-FF-92	12/6/2011	67	66	x	x	x	74	2	503	65	577	3
IP1-FF-93	12/6/2011	68	67	x	x	x	74	2	503	55	577	1
IP1-FF-94	12/6/2011	67	66	x	x	x	74	2	503	65	577	1
IP1-FF-95	12/6/2011	62.5	61.5	x	x	x	74	2	503	90	577	1
IP1-FF-96	12/6/2011	69	67	x	x	x	74	2	503	100	577	0.2
IP1-FF-97	12/9/2011	58.5	58.5	x	x	x	74	2	503	65	577	0.5
IP1-FF-98	12/12/2011	25	15	x	x	x	54	1	377	45	577	1
IP1-FF-99	12/12/2011	25	15	x	x	x	54	1	377	55	577	1
IP1-FF-100	12/12/2011	25	15	x	x	x	54	1	377	55	577	1
IP1-FF-101	12/12/2011	25	15	x	x	x	54	1	377	55	577	2
IP1-FF-102	12/6/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-103	12/6/2011	17	7	55	30	40	x	x	125	30	160	2
IP1-FF-104	12/7/2011	17	7	55	30	40	x	x	125	30	160	3

Table 2
Injection Data

Injection Point	Date	Bottom Injection Depth [ft bgs]	Top Injection Depth [ft bgs]	RegenOx Part A [lbs]	RegenOx Part B [lbs]	ORC Advanced [lbs]	3D Micro Emulsion	BDI (L)	Water Volume [gal]	Injection Pressure [psi]	Total Injected Volume [gal]	Flow Rate [gpm]
IP1-FF-105	12/7/2011	16	7	55	30	40	x	x	125	30	160	3
IP1-FF-106	12/7/2011	17	7	55	30	40	x	x	125	30	160	4
IP1-FF-107	12/7/2011	14	7	55	30	40	x	x	125	30	160	2
IP1-FF-108	12/7/2011	17	7	55	30	40	x	x	125	30	160	3
IP1-FF-109	12/7/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-110	12/7/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-111	12/8/2011	16	7	55	30	40	x	x	125	30	160	1
IP1-FF-112	12/8/2011	17	7	55	30	40	x	x	125	30	160	0.5
IP1-FF-113	12/8/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-114	12/8/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-115	12/8/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-116	12/6/2011	17	7	55	30	40	x	x	125	30	160	1
IP1-FF-117	12/13/2011	25	15	x	x	x	54	1	377	30	431	1
IP1-FF-118	12/13/2011	25	15	x	x	x	54	1	377	30	431	2
IP1-FF-119	12/13/2011	25	15	x	x	x	54	1	377	30	431	1
IP1-FF-120	12/13/2011	25	15	x	x	x	54	1	377	30	431	2
IP1-FF-121	12/13/2011	25	15	x	x	x	54	1	377	30	431	1
IP1-FF-122	12/13/2011	25	15	x	x	x	54	1	377	30	431	1
IP1-FF-123	12/14/2011	25	15	x	x	x	54	1	377	30	431	1
IP1-FF-124	12/14/2011	25	15	x	x	x	54	1	377	30	431	2
IP1-FF-125	12/14/2011	25	15	x	x	x	54	1	377	30	431	2
IP1-FF-126	12/14/2011	25	15	x	x	x	54	1	377	30	431	3

* "x" indicates that material was not intended for injection at that location

TABLE 3

FF AREA WELLS

VOC SUMMARY ANALYTICAL RESULTS

TABLE 4
FF AREA WELLS
NATURAL ATTENTUATION PARAMETERS

TABLE 5
FORMER APA WELLS
VOC SUMMARY ANALYTICAL RESULTS

TABLE 6

FORMER APA WELLS

NATURAL ATTENTUATION PARAMETERS

TABLE 7

FORMER BULK CHEMICAL STORAGE AREA WELLS

VOC SUMMARY ANALYTICAL RESULTS

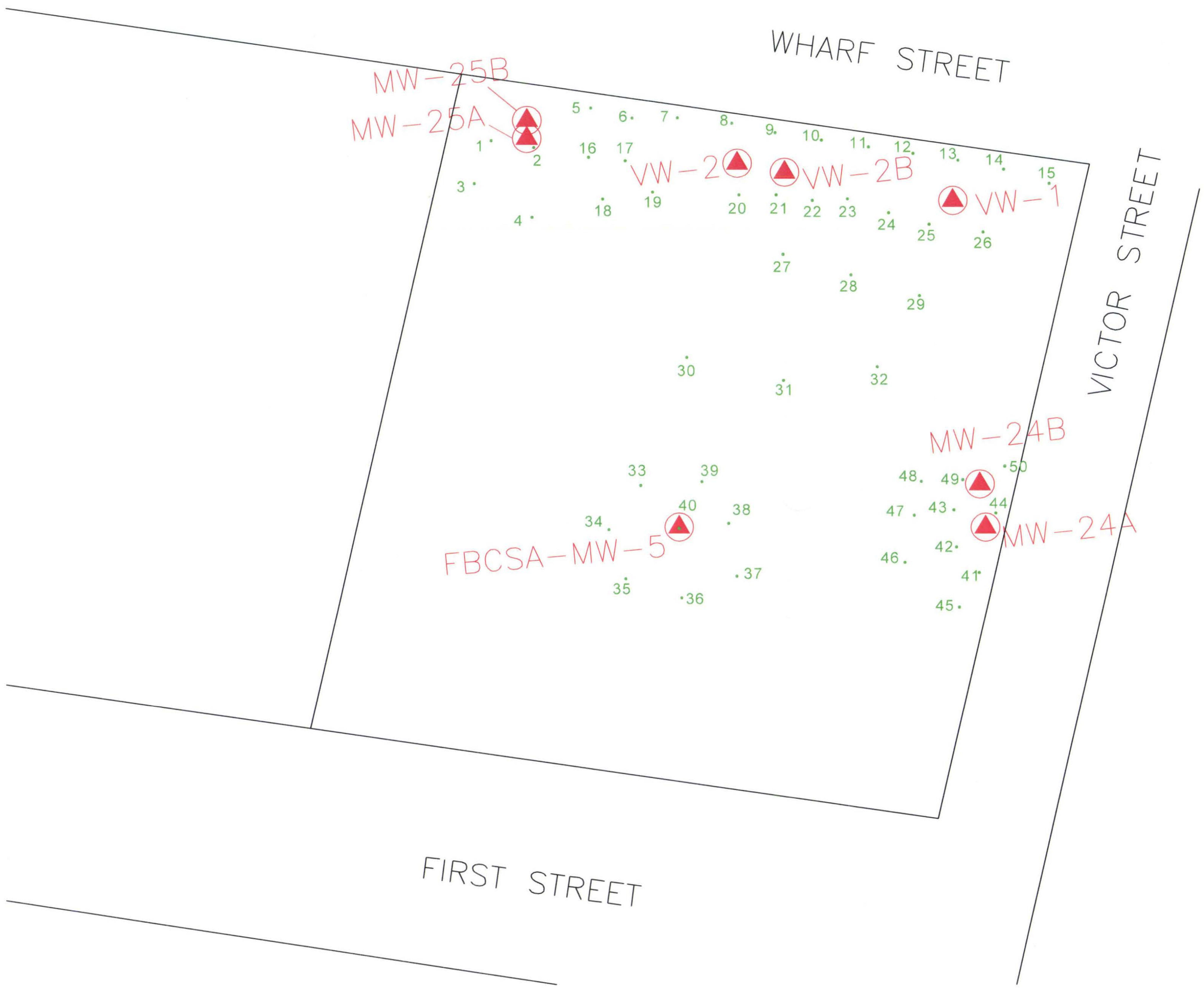
TABLE 8

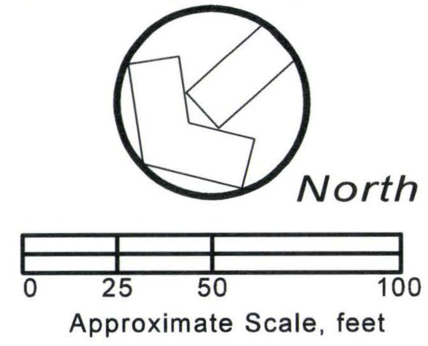
FORMER BULK CHEMICAL STORAGE AREA WELLS

NATURAL ATTENTUATION PARAMETERS

Project #2950

Environmental Operations, Inc.





Legend

• 10 "IP1 - FBCSA - 10" (typ)

FBSCA Injection Points
November - December 2011

Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 13

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Project #2950

Environmental Operations, Inc.

APA Injection Points
November - December 2011

Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 14

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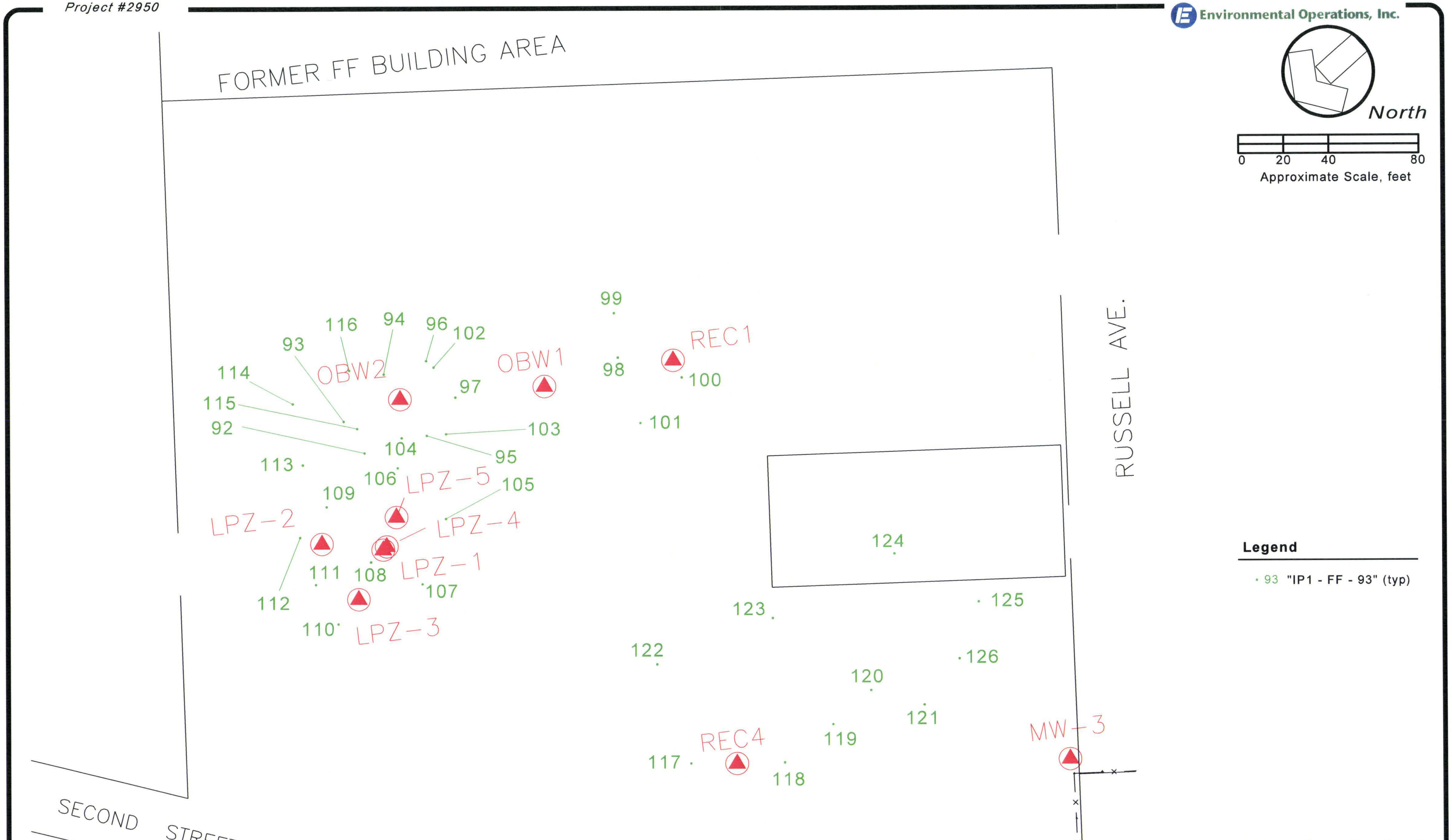

FF Area Injection Points
November - December 2011
Former Solutia Queeny Plant
Saint Louis, Missouri

Figure 15

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